

Astronomy Activity Book



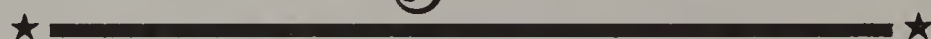
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By DENNIS SCHATZ
Drawings by ROY DOTY

With Star-Finder Wheel



Astronomy Activity Book



By DENNIS SCHATZ

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With Star-Finder Wheel



LITTLE SIMON

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*To Andy and Alan,
who know how to inspire others
about the wonders of astronomy*

ACKNOWLEDGMENTS

My greatest appreciation goes to the astronomy lovers of all ages who inspired this book. The teachers and students of the Edmonds School District Challenge Program were essential in making sure the activities were successful.

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Having been involved in the inspiration for the Sky Challenger concept, I appreciate receiving permission to adapt the concept for use in this book. Sky Challenger was developed by the Lawrence Hall of Science with financial support by the National Science Foundation.

PHOTO CREDITS

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Foreword



This book is written to appeal to children ages 10 and older. The combination of activities and explanatory information is designed to encourage the greatest understanding of astronomy, and to encourage the development of good reasoning skills. When possible, the activities use other disciplines besides science, including art, language arts, and mathematics.

The activities have been used many times with different groups of children and are effective with individual children and families as well as with groups of children in classrooms or youth group meetings.





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Introduction

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The activities in this book encourage you to step outside and discover space and time.

Discover that stars are more than faint points of light in random patterns around the sky. They are beacons of the past. Their light tells us what they were like when the light left the stars hundreds to thousands of years ago.

Scan the sky with binoculars to reveal other fascinating and strange objects. Vast nebulae of glowing gas show the birthplace of stars. A globular cluster of 100,000 stars is seen as it was 30,000 years ago when giant mastodons roamed the earth. The faint Andromeda galaxy with over 200 billion stars (200,000,000,000) shows us what it was like over two million years ago when the light began traveling our way—about the time that the first humans were beginning to walk on the face of the earth.

Discover how the never ending cycle of the moon's phases helps explain the pattern of solar and lunar eclipses. The lunar surface reveals craters, mountains, and maria unchanged since the formation of our solar system more than four billion years ago. These features provide clues to how the moon, the earth, and even we came to exist.

The sun is seen not only as a provider of light and warmth, but as a relatively nearby star that can be closely studied. It shows stars to be large balls of bubbling gas with a surface temperature of 3,000 F to 100,000 F, hot enough to melt most



The Orion Nebula, a vast cloud of gas, glows brightly near the bottom of a star field containing over a thousand stars.



The lunar surface shows craters, mountains, and maria that formed billions of years ago.

substances on the earth. Sunspots, large solar storms the size of the earth, can be seen on the surface of the sun. These storms generate massive explosions that send high-speed atomic particles toward

the earth, sometimes disrupting radio communications.

Now you can begin your exploration of the fascinating experiences to be found in the sky.





Moon Gazing:



Predicting Phases and Features

Everyone has a mental image of how the moon looks. Often this is a single image such as the full moon. This activity tests how much you already know about the moon's appearance and makes your observations in the next two activities more meaningful.

WHAT YOU NEED

Lunar photographs on this page

Scissors

Pencil

Tape

Sheet of paper



WHAT TO DO

1) Cut out the photographs and place them on the sheet of paper in the order you think you would see them if you observed the moon during several weeks.

2) Once you are satisfied with the order, tape them to the paper. Be sure to show which way is up and number them one through six in the order each would be seen.

3) How does your prediction differ from these two? What reasons can you give for which prediction is best?

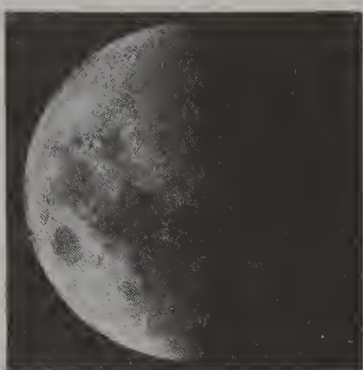
4) To determine the correct order for the photographs, complete the observing portion of the activity that follows.



How do your predictions compare to these two?



1



2



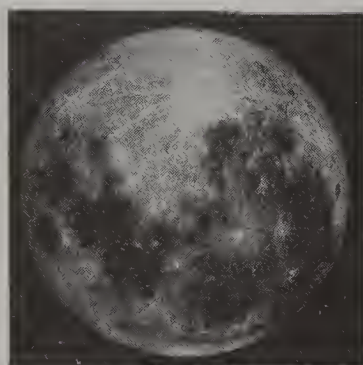
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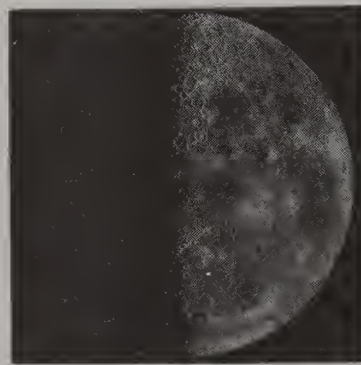
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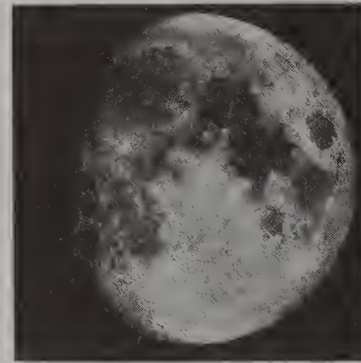
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5



6



5



6

★★

Observing Phases and Features

To determine the correct order and orientation (what part of the phase is at the top) of the six lunar photographs, you have to go out and observe the moon for the next two to four weeks. The lunar observing chart in this activity will help you keep track of your observations.

WHAT YOU NEED

Moon Recording Chart

Pencil

Binoculars (optional)

Clipboard or other hard writing surface

WHAT TO DO

1) Start this activity on a clear day when you can see the moon in the sky. The moon is often visible in the daytime as well as at night, so you will want to look around the sky every couple of hours to determine when you can see the moon.

2) If you are not having any luck locating the moon, check the local newspaper for the rising and setting time of the moon. This is usually found with the weather information. Check the sky anytime from about an hour after the moon rises to about an hour before it sets. You should be able to find the moon unless you are trying to observe within a few days of a new moon, when the moon is sometimes difficult to see. Try again three or four days after the new moon.

3) Once you have found the moon, indicate the date and time of your observation on your Moon Recording Chart. Then draw the shape of the moon. Examine the eight phases at the top of the Recording Chart and write down the phase that is closest to what you see. There may be times when the observed phase appears similar to two different phases. Do your best to choose one of the phases, but make a note of this similarity in the Comments section of the Recording Chart.

4) Use the comment area to record any other interesting observations, such as the direction you were looking, the

height of the moon above the horizon, or the cloud conditions.

5) After you determine the moon's phase, look closely at the different features you can see on the lunar surface. Try to locate the different features you saw on the photographs from the previous activity. See if these features can help you determine the correct orientation for the photographs. Binoculars provide a better look at the different features. You can also use a telescope to observe the lunar features. Many telescopes invert or reverse the image you see, so be sure to notice whether you are seeing the moon upside down or reversed left to right.

6) After each day's observation, compare your results with the prediction you made using the photographs. After a few days, you should begin seeing a pattern in the moon's phase. By the seventh to tenth day, you will be able to tell whether your prediction for the order of the phases was correct. You should also see enough features on the moon to determine whether you had the correct orientation for each photograph—except the crescent phases, which do not show enough features for comparison.

7) If your prediction of the order and orientation for the photographs needs to be changed, make a new prediction after seven to ten days of observations.

MOON RECORDING CHART



New



Waxing Crescent



Waning Crescent



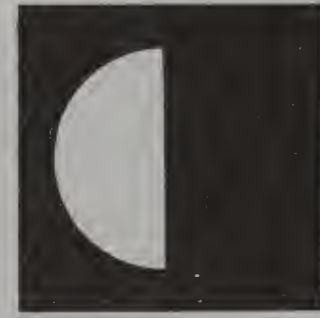
Waxing Gibbous



Waning Gibbous



Full



3rd Quarter



1st Quarter

[illegible]

Moon Features

graph to produce the same sequence of phases. For example, either photograph of the quarter moon can look like the first quarter depending on how the photo is oriented.



Craters and Rays

The force of the impact often splashes up rock that spreads across the surrounding area in long, thin rays that all extend away from the crater. This is especially visible in the crater Tycho, where some rays of ejected material extend for more than 1,000 miles.

Maria (Latin for “seas”) are the large dark features on the moon. Astronomers believe they formed several billion years ago just after the moon was created and when it still had a thin crust. Large meteoroids hit the moon with such force that they broke through the crust, and molten lava from below filled shallow basins on the moon. The lava cooled into the large flat areas we see as maria. The maria are darker than the surrounding areas because the rock is basalt, a volcanic rock that is darker than the material making up the surrounding mountains.

Mountains are especially easy to see around the edge of most maria. The mountains probably formed over four billion years ago, shortly after the moon's crust formed, when most of the moon was still hot and molten. As the material cooled, the moon shrank slightly, making the outer layer buckle. This pushed rocks up to form the mountainous features we see today. Because the lack of an atmosphere means almost no erosion occurs, the moon's mountains have changed little since they were formed billions of years ago. This is unlike the earth's mountains, which have changed greatly due to erosion by wind and water.

During your lunar observations, you should have discovered that the moon phases progress in the order shown on page 16. Although many people think of

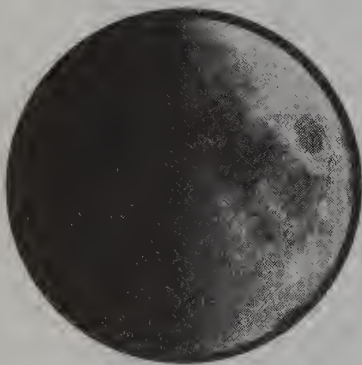
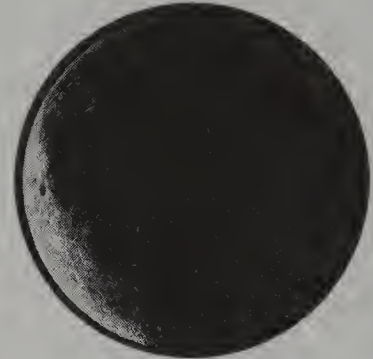
15

THE LUNAR PHASES

New moon occurs when the lighted side of the moon is facing away from earth. The next new moon will occur about $29\frac{1}{2}$ days after this one.

This waxing crescent occurs about three days after new moon. All the phases between new moon and first quarter are called waxing crescent.

This waning crescent occurs about 24 days after new moon. All phases between third quarter and new moon are called waning crescent.



First quarter moon occurs approximately seven days after new moon, when exactly $\frac{1}{4}$ of the moon is visible to viewers on the earth.

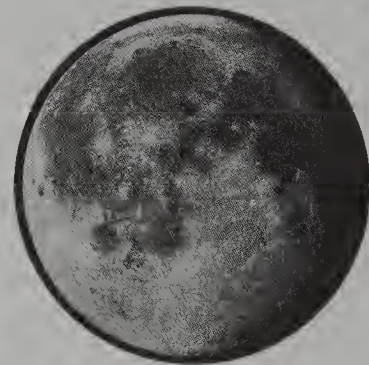
Third quarter occurs about 22 days after new moon when exactly $\frac{1}{4}$ of the moon is visible to viewers on the earth.



This waxing gibbous occurs about 11 days after new moon. All the phases between first quarter and full moon are called waxing gibbous.



Full moon occurs a little over 14 days after new moon when the lighted side of the moon is facing toward earth.



This waning gibbous occurs 17 days after new moon. All phases between full moon and third quarter are called waning gibbous.

Although these photographs show all the phases oriented straight up and down, this is not how each phase will always look. Depending on where the moon is in relation to the horizon and the sun, the exact orientation of the shape may vary.

A good way to recall which phases are the waxing and which are the waning is to remember that when you wax a car you are building up the wax on the car. Thus, the waxing phases are when the sunlit portion of the moon visible on the earth is getting larger. When the sunlit portion wanes away—gets smaller—the moon is in its waning phases. The waxing phases are from new moon to full moon and the waning phases are from full to new moon.

Many people use the term half moon rather than quarter moon because it appears that you can see only half the moon in the sky. As you see half the side of the moon facing toward the earth, the half moon name makes sense. But there is an entire half of the moon we cannot see that is facing away from the earth. First and third quarter are then logical terms because we are really seeing only a quarter of the entire moon.

The views of the moon shown in this book are for a typical observer in the middle latitudes of the Northern Hemisphere (North America, Europe, Asia). If you visit other parts of the world, repeat your observations of the moon to discover any differences.



Modeling Phases

This activity shows you how to make a model of the earth, sun, and moon to discover why the moon phases occur. This information can then be used to predict lunar and solar eclipses.

WHAT YOU NEED

- (Adult supervision may be needed during this activity)
- Lamp with its shade removed
- Old tennis ball (most light-colored balls will work)
- Your head
- Pencil
- Totally dark room

WHAT TO DO

- 1) Place lamp on table. Remove the shade and turn on the lamp. This will be the sun in your model. **BE CAREFUL TO KEEP ANYONE FROM TOUCHING THE BULB WHILE IT IS ON OR JUST AFTER IT IS TURNED OFF, AS THE HOT SURFACE CAN CAUSE A SEVERE BURN.**
- 2) Stand 10 to 15 feet away from the light. The light is the sun and your head is the earth. The top of your head is the north pole and your eyes are your location on the earth. While standing in one place, slowly spin around in a circle going from your right to left. This models the daily movement of the earth that makes the sun, moon, and all other objects in the sky appear to rise and set once a day. It is daytime on your model earth when

you can see the light bulb. It is nighttime when you cannot see the bulb.

3) Punch small hole in tennis ball so that the pencil will fit snugly inside.

4) Place the moon in your model by holding the ball at arm's length in the general direction of the lamp. The spinning earth—your head—makes the moon rise and set each day, but this does not affect the phase of the moon. The phases are caused by movement of the moon around the earth. This can be demonstrated by moving the ball from your right to left in orbit around your head. Move your model moon slowly in orbit around the earth and watch it go through its different phases. Determine where in its orbit the moon must be to show the following phases, and then draw the moon's position in each diagram. The first drawing is completed as an example:



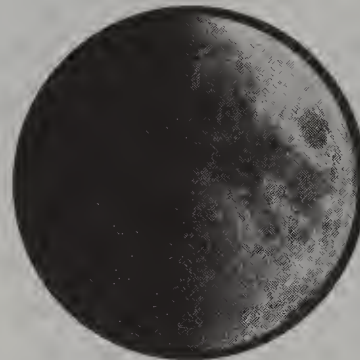
Move the ball (moon) slowly in orbit around your head (earth) and watch the ball show different phases.



Full moon



New moon



First quarter



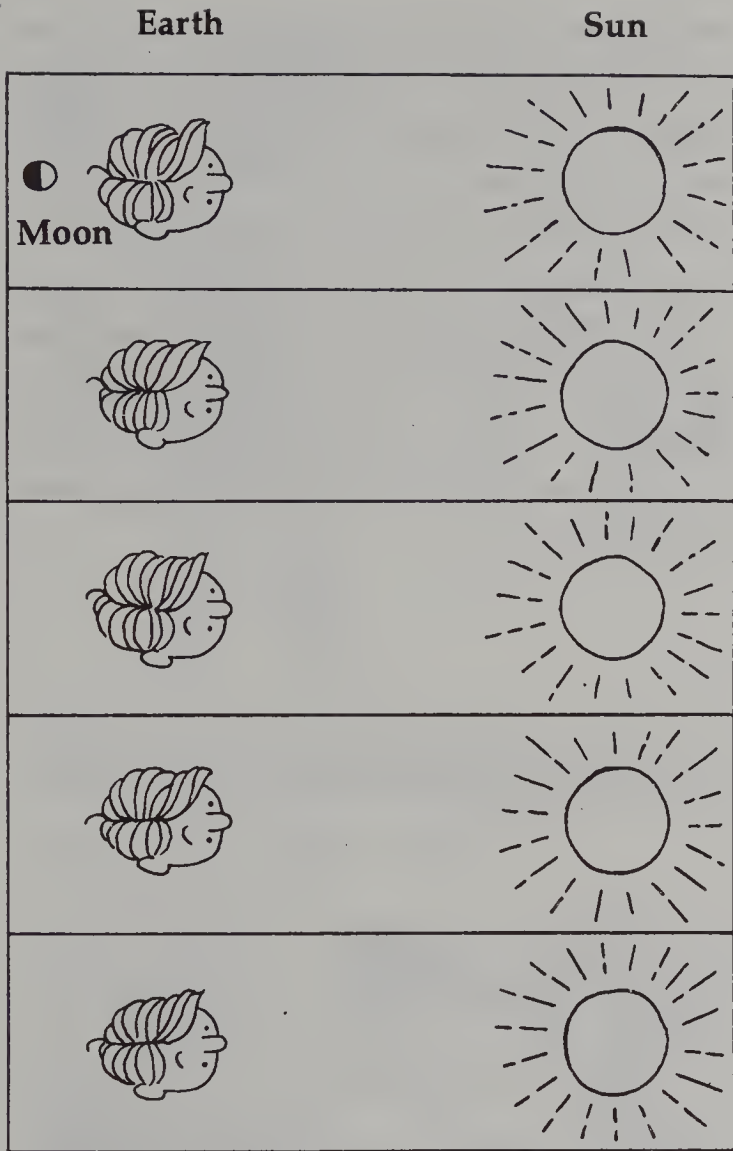
Waxing crescent



Waning gibbous

5) Check your positions for the moon against those in the Moon Phase diagram that follows.

The moon goes through a full set of phases every $29\frac{1}{2}$ days. The phase it shows at any given time is determined by the position of the moon relative to the sun and earth. When the moon is between the earth and sun, the lighted

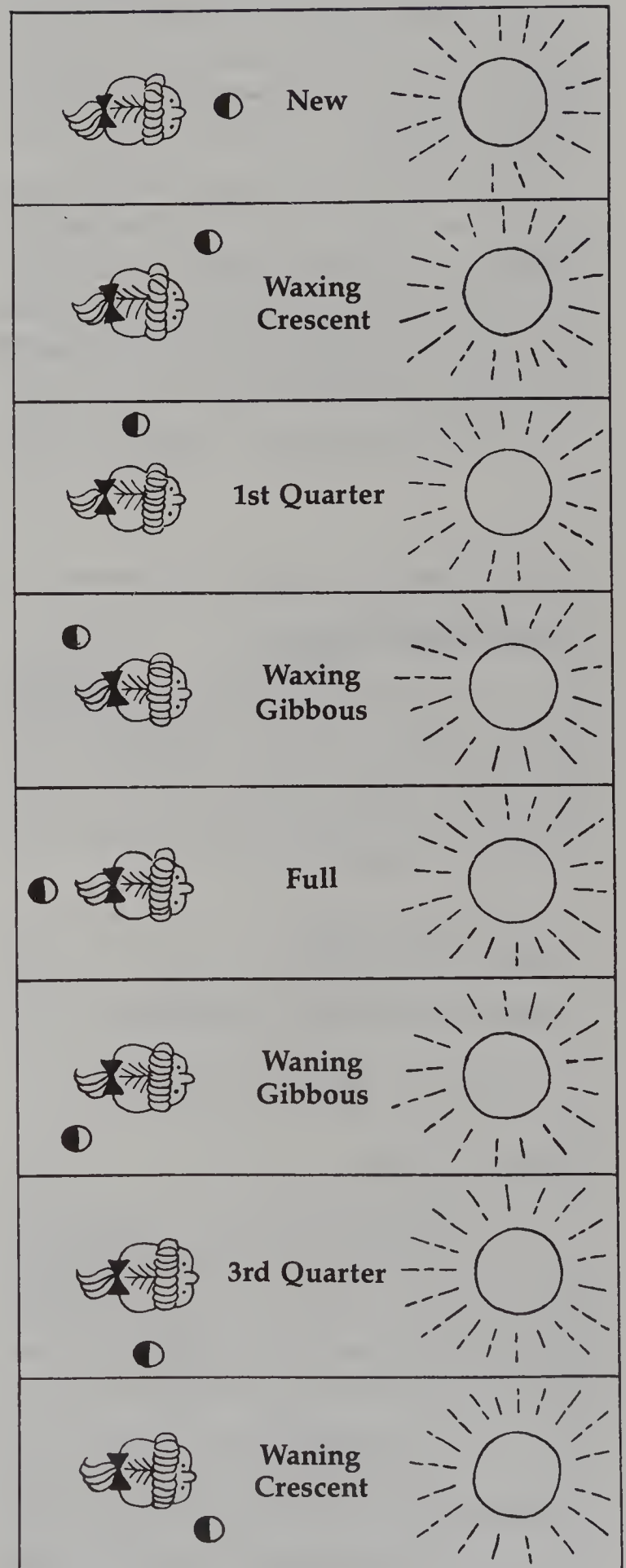


Draw where the moon ball must be placed to give the phases shown at left. See example for full moon.

part of the moon faces away from the earth, giving us a new moon.

As the moon moves in its orbit around the earth, we begin to see a small portion of the sunlit side of the moon. This gives a thin, crescent-shaped moon.

As the moon continues to orbit the earth, the crescent shape becomes wider (waxes). When there is a right angle (90 degrees) between the moon, earth, and sun, we see the first quarter moon. Calendars that give the time when the first quarter occurs are showing when there is



an exact 90-degree angle between the earth, moon, and sun. Calendars do not give times for the crescent or gibbous moon because these phases last for a number of days.

As the moon moves farther around the earth, the moon leaves the first quarter phase and becomes a waxing gibbous. The gibbous shape grows larger until the moon is on the opposite side of the earth from the sun, when we see a full moon.

The waning phases begin after the

moon passes its full stage. The sunlit portion of the moon visible to the earth gets smaller with the left side of moon being sunlit. The waning gibbous phases occur from full moon until the moon is again at a right angle to the earth and sun, when we see the third quarter phase. The waning crescent moon occurs after the third quarter, becoming thinner until the moon completes the cycle by becoming a new moon again.

Modeling Eclipses

Your model of the earth, moon, and sun can also help you understand what causes lunar and solar eclipses. This activity explores why, when, and how often solar and lunar eclipses occur.

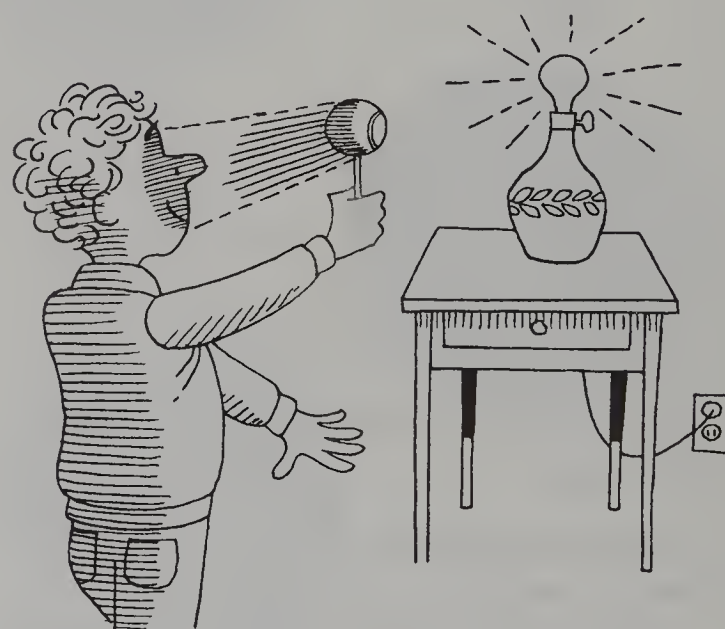
WHAT YOU NEED

Same items from last activity

A friend or relative to assist you

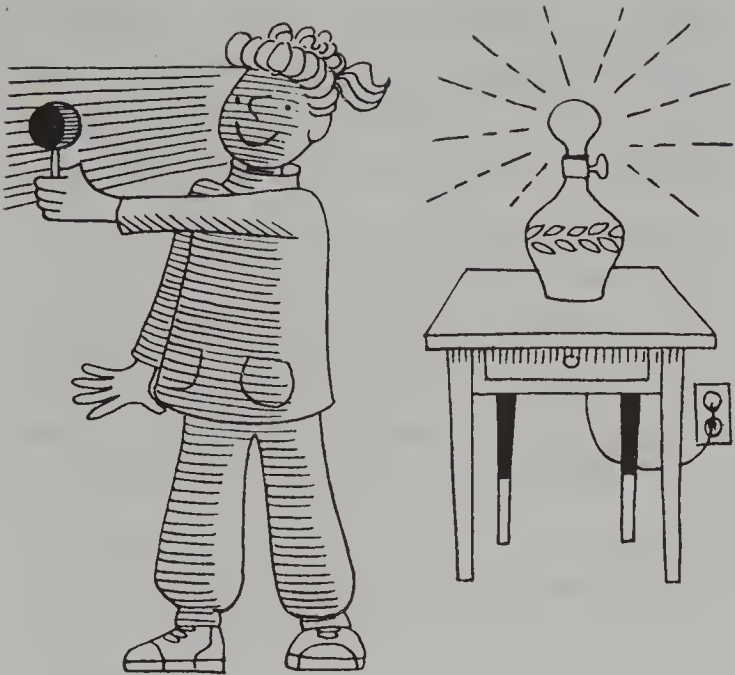
WHAT TO DO

1) A solar eclipse occurs whenever the moon passes directly in front of the sun. Set up your moon-earth-sun model as you did in the last activity. Hold the moon ball at arm's length and close one eye so you view from only one location on the earth rather than two. Move your moon in orbit around the earth until the moon ball covers the sun, producing a solar eclipse. What phase does the moon have?



When the moon is directly between the sun and earth, the moon's shadow falls on the earth. This is a solar eclipse.

2) A lunar eclipse occurs when the moon passes through the shadow of the earth. Move your model moon in orbit around the earth until the moon falls into the shadow of your head. What phase does the moon show as it goes into your shadow?



When the earth is directly between the sun and moon, the earth's shadow falls on the moon. This is a lunar eclipse.

3) Continue moving the moon in its orbit around the earth, remembering that the moon takes $29\frac{1}{2}$ days to make one complete revolution. How often do you predict there should be solar and lunar eclipses?

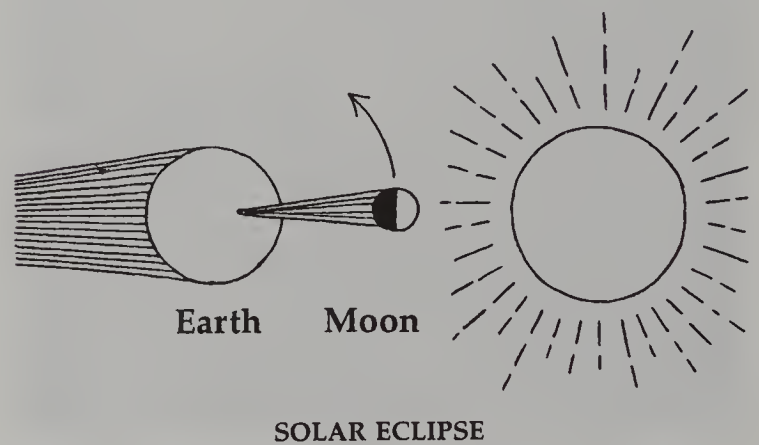
4) Have a friend or relative take your place, holding the moon ball so it produces a solar eclipse. Look at the shadow of the moon falling on the face of your friend or relative. If the person's head were the earth, only those observing from where the moon ball's shadow falls would see a total eclipse of the sun.

5) Now have the friend or relative hold the moon ball so there is a lunar eclipse. If the person's head were the earth, from what part of the earth could people see the lunar eclipse? Are more people going to see the lunar eclipse or the solar eclipse?

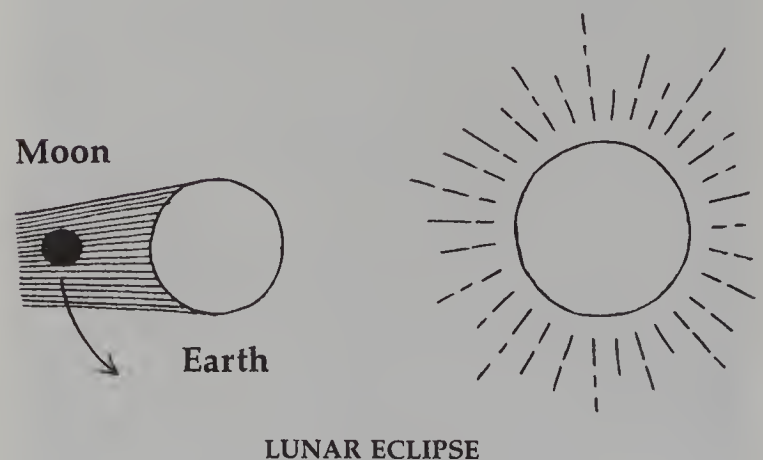
The first part of this activity shows that

eclipses can occur only when the moon is in certain phases. To have a solar eclipse, the moon must come directly in front of the sun, which means the portion of the moon facing away from the earth is sunlit. Observers from the earth see a new moon.

To have a lunar eclipse, the earth, moon, and sun must again be in a straight line, but now the moon and sun must be in opposite directions from the earth. This can occur only when the moon is full.



Moon must be in new phase. Only those people in a small region of earth where the moon's shadow falls can see the solar eclipse.



Moon must be in full phase. All people on the night side of the earth can see lunar eclipse.



The two hoops represent the path of the sun and moon. The moon takes $29\frac{1}{2}$ days to complete one orbit, while the sun takes one year.

If you move your model moon in its orbit, you can easily produce a solar and lunar eclipse each time it goes around the earth. A reasonable conclusion is that a solar and lunar eclipse should occur every $29\frac{1}{2}$ days. However, this does not correspond with our everyday experience, which indicates that eclipses are rare events.

To understand how often eclipses occur, we must examine more closely the path of the sun and moon through the sky. A good way to show these paths using our model earth, moon, and sun is to think of the sun and moon attached to two hoops circling your head. The inside hoop is the orbit of the moon, with the moon making one complete revolution each $29\frac{1}{2}$ days. The outside hoop is the apparent path of the sun. The word *apparent* is used because the earth actually goes around the sun. This makes the sun

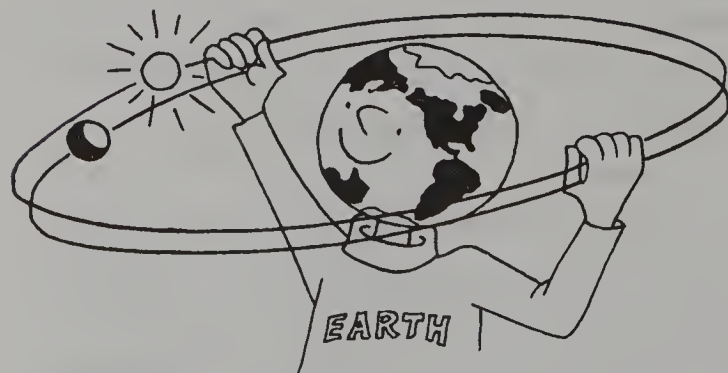
appear to be following a path around the earth. This *apparent* path is called the ecliptic. Since the earth takes one year to complete its orbit around the sun, the sun appears to take a year to move completely around the ecliptic.

The orbital motions of the earth and moon should not be confused with the daily rising and setting of the sun and moon. These are due to the rotation of the earth.

If the two orbits were exactly aligned,



The daily rotation of the earth causes the moon and sun to rise and set each day, but does not cause eclipses.



If the path of the sun and moon are aligned, observers on the earth experience lunar and solar eclipses every $29\frac{1}{2}$ days.



Path of moon and sun are at slight angles to each other. This causes eclipses to occur only when both the moon and sun are at crossing points of orbits. This occurs approximately every six months.

then lunar and solar eclipses would occur every $29\frac{1}{2}$ days. However, the two orbits are at slight angles to each other so that most of the time the moon passes above or below the direction of the sun or the earth's shadow. In order for there to be an eclipse, the earth, moon, and sun must be in a straight line. This occurs only when the moon and sun are at the crossing points of their orbits, where the two hoops cross each other in the model. Although the moon is at these crossing points approximately twice a month, the sun is at the intersections only twice a year.

When the sun is at a crossing point, the motion of the moon is sufficiently quick so that both a lunar and a solar eclipse occur within about 14 days of each other. Approximately six months later there is another pair of eclipses when the sun is located at the other crossing point.

On rare occasions, the sun stays close enough to the crossing point long enough so that three eclipses occur within a month. For example, if the moon passes

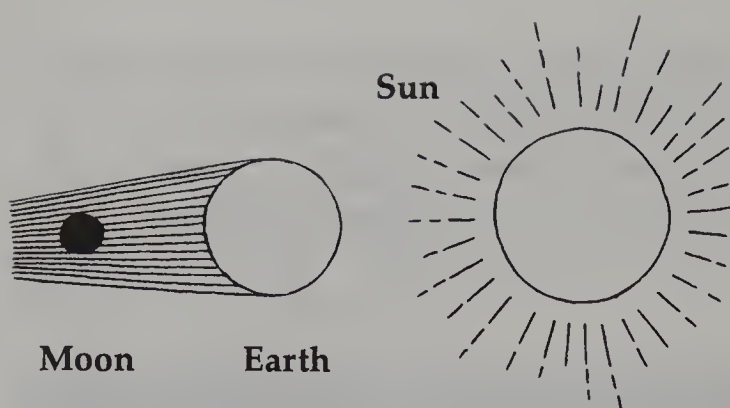
in front of the sun (a solar eclipse) just as the sun reaches the intersection of the two paths, then a lunar eclipse occurs about 14 days later. Another solar eclipse



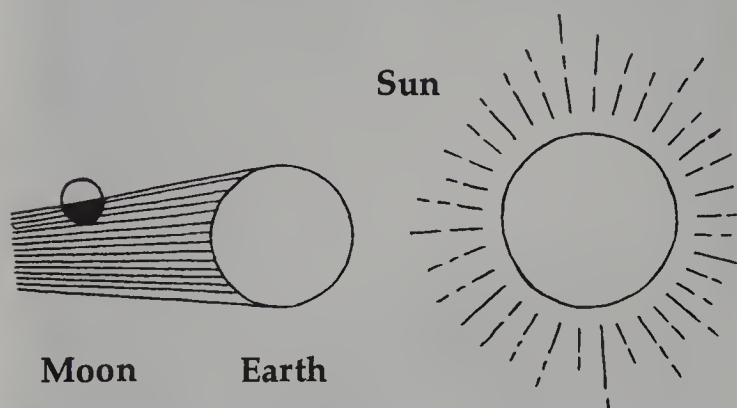
Partial solar eclipse, October 12, 1977.



Total solar eclipse, February 16, 1979.



Total lunar eclipse occurs when moon passes completely into shadow of earth.



Partial lunar eclipse occurs when moon passes partly through shadow of earth.

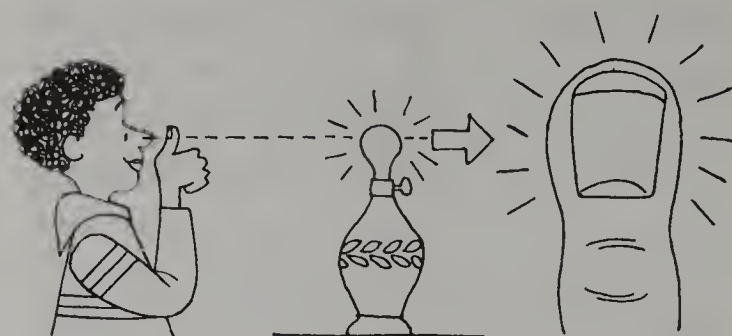
would then occur 14 days later just as the sun is leaving the crossing point.

The complex motions of the earth, moon, and sun actually cause the time between eclipses to be slightly less than six months. This means that on extremely rare occasions when the first eclipse occurs in early January, there are three sets of eclipses in one year. This occurred in 1982, when there were a total of 4 solar eclipses and 3 lunar eclipses.

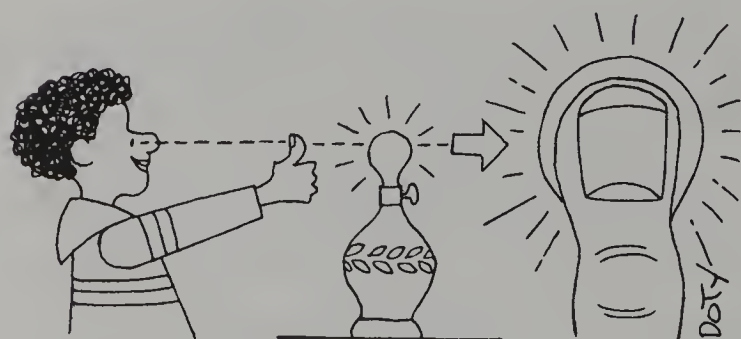
Just because an eclipse occurs does not mean that it is a total eclipse. If the moon is slightly above or below the exact direction of the sun, then a partial eclipse occurs. You can easily produce this in your model earth-moon-sun system by moving your moon ball in orbit so that

the ball only partially covers the sun or just skims the edge of your head's shadow.

A third type of solar eclipse is also possible. This type of eclipse, called an annular eclipse, is best demonstrated by using your thumb to represent the moon. If you stand a few feet away from your model sun with one eye closed, you should be able to move your thumb forward and backward between the sun so that a total solar eclipse occurs. If you hold your hand at arm's length, you find that the size of your thumb is too small to cover the sun completely. A ring of light called an annulus shines around your thumb. Since the moon's distance from the earth varies slightly, sometimes the moon is



Thumb held close to eye completely covers light, producing a total eclipse.



Thumb held far from eye leaves ring (annulus) of light bulb visible around thumb, producing an annular eclipse.



Multiple exposure photograph of moon moving in front of sun to produce an annular eclipse, April 19, 1977.

close enough to the earth to produce a total eclipse and sometimes it is far enough away that an annulus of solar surface is visible during the eclipse, making an annular eclipse visible on the earth.

Observers located on more than half of the earth can see a lunar eclipse. But only a small part of the earth gets to experience a total solar eclipse. The path of the moon's shadow as it crosses the earth's surface is less than 300 miles wide. On the average, a total solar eclipse occurs only once every 360 years for a single

location on the earth. A total solar eclipse is also the one time that most earth-bound viewers can see the beautiful solar upper atmosphere called the solar corona. Viewing a total solar eclipse is often a once-in-a-lifetime event and well worth traveling long distances to see.

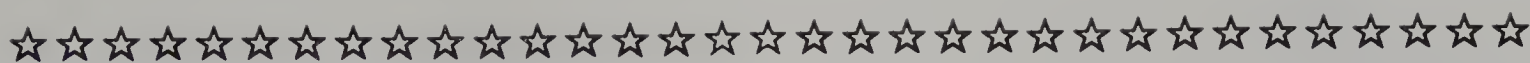
If you have the opportunity to see a solar eclipse, an ideal way to do it is to project the sun's eclipsed image using binoculars — page 32.

Here is a list of where total eclipses will occur during the next 25 years.



TOTAL SOLAR ECLIPSES: 1991
THROUGH 2017

<i>Date</i>	<i>Location</i>	<i>Date</i>	<i>Location</i>
July 11, 1991	Hawaii, North Pacific Ocean, Mexico, Central America, South America	December 4, 2002	South Atlantic Ocean, Southern Africa, Indian Ocean, Australia
June 30, 1992	South America, South Atlantic Ocean	March 29, 2006	Atlantic Ocean, Northern Africa, Middle East, Soviet Union
November 3, 1994	South Pacific Ocean, South America, South Atlantic Ocean, Indian Ocean	August 1, 2008	Northern Canada, Greenland, North Atlantic Ocean, Soviet Union, China
October 24, 1995	Middle East, India, Southeast Asia, South Pacific Ocean	July 22, 2009	India, China, South Pacific Ocean
March 9, 1997	Soviet Siberia, Arctic Ocean	July 11, 2010	South Pacific Ocean, Southern South America
February 26, 1998	Pacific Ocean, South America, North Atlantic Ocean	November 13, 2012	Australia, South Pacific Ocean
August 11, 1999	North Atlantic Ocean, Europe, Middle East, India	March 20, 2015	North Atlantic Ocean
June 21, 2001	South Atlantic Ocean, Southern Africa, Madagascar, Indian Ocean	March 9, 2016	Indonesia, Borneo, Pacific Ocean
		August 21, 2017	North Pacific Ocean, United States, North Atlantic Ocean



Sun Watching:



Making a Pocket Sun Clock

Our concept of time is based on the motion of the sun. Keeping track of the sun's shadow with your Pocket Sun Clock will help you understand the sun's motion and our concept of time.

WHAT YOU NEED

Pocket Sun Clock for your location (see page 29)

Cardboard slightly larger than the Sun Clock

String 20cm (7 in) long

Glue

Chalk or pencil

Scissors

Tape

WHAT TO DO

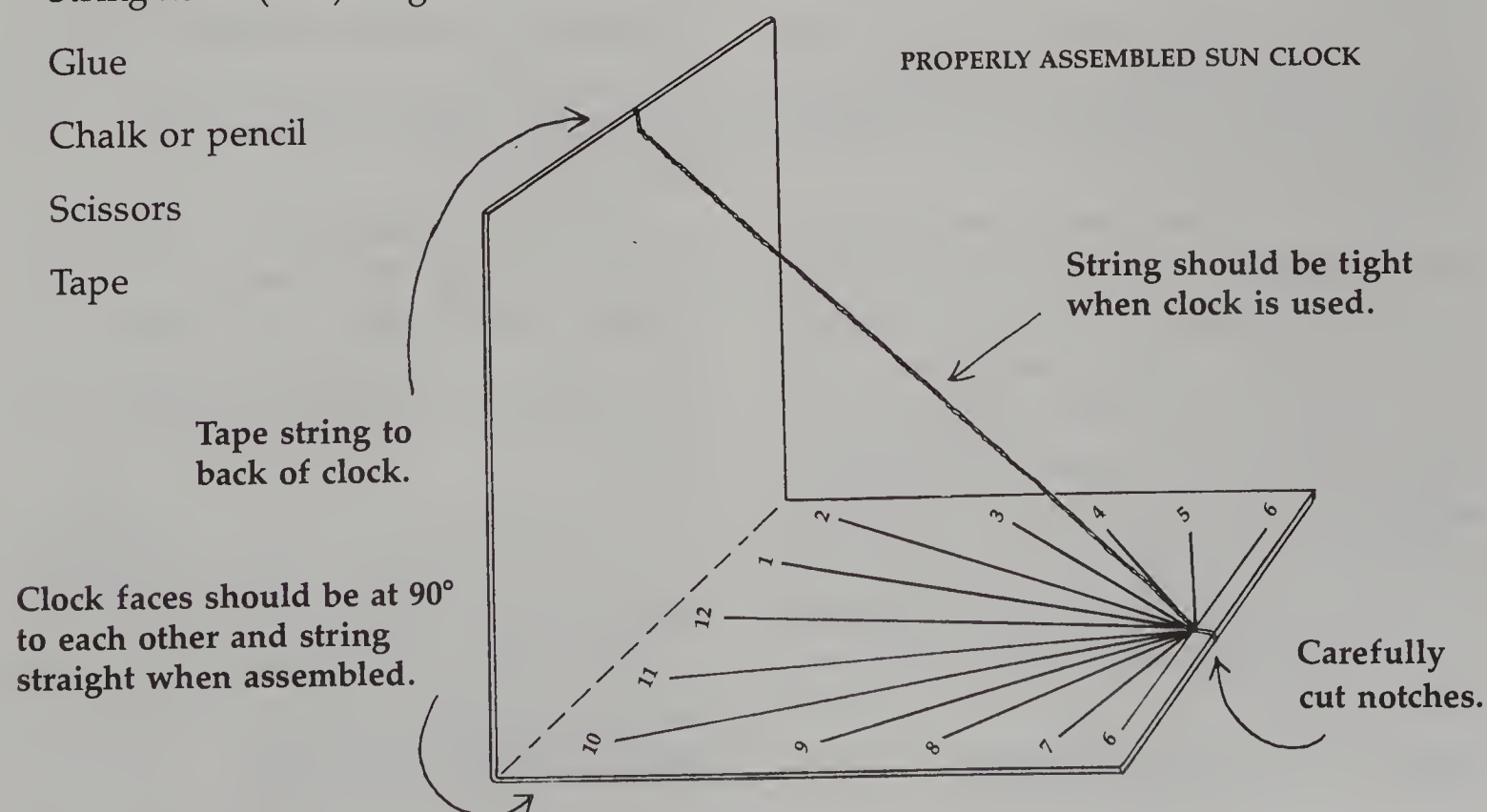
1) Use the most appropriate Sun Clock for your location.

2) Cut out the Sun Clock and glue it to the piece of cardboard.

3) Cut the cardboard to the size of the Sun Clock.

4) Cut as accurately as possible the short notches at each end as indicated on the Sun Clock.

5) Fold the Sun Clock along the dotted line as shown. Be sure the hour lines are folded to the inside.





6) Place one end of the string through one of the notches and tape the end of the string to the back of the Sun Clock.

7) Stretch the other end of the string through the notch at the other end of the Sun Clock. Adjust the string so that it is tight when the two ends of the Sun Clock are at a 90-degree angle. Tape the end of the string to the back of the Sun Clock.

8) Before going outside to try your Sun Clock, check the time. If your clock is on daylight saving time, subtract one hour to give standard time.

9) Once you have the correct standard time, go outside to a sunny location where there is a flat surface. Be sure the location will be in the sun for at least the next half hour. Place the Sun Clock on the flat surface so the hour lines are on the surface and the other half of the Sun Clock is straight up and down with no bend in the string. Rotate the Sun Clock around until the shadow of the string reads the correct time.

10) Use the pencil or chalk to draw a

box around the base of the clock so you can tell exactly how the Sun Clock is oriented.

11) To best understand how the Sun Clock works, think about how you will need to move your Sun Clock so it reads the correct time when you return in 15 to 45 minutes. Will you need to change its orientation? How much will you need to move it?

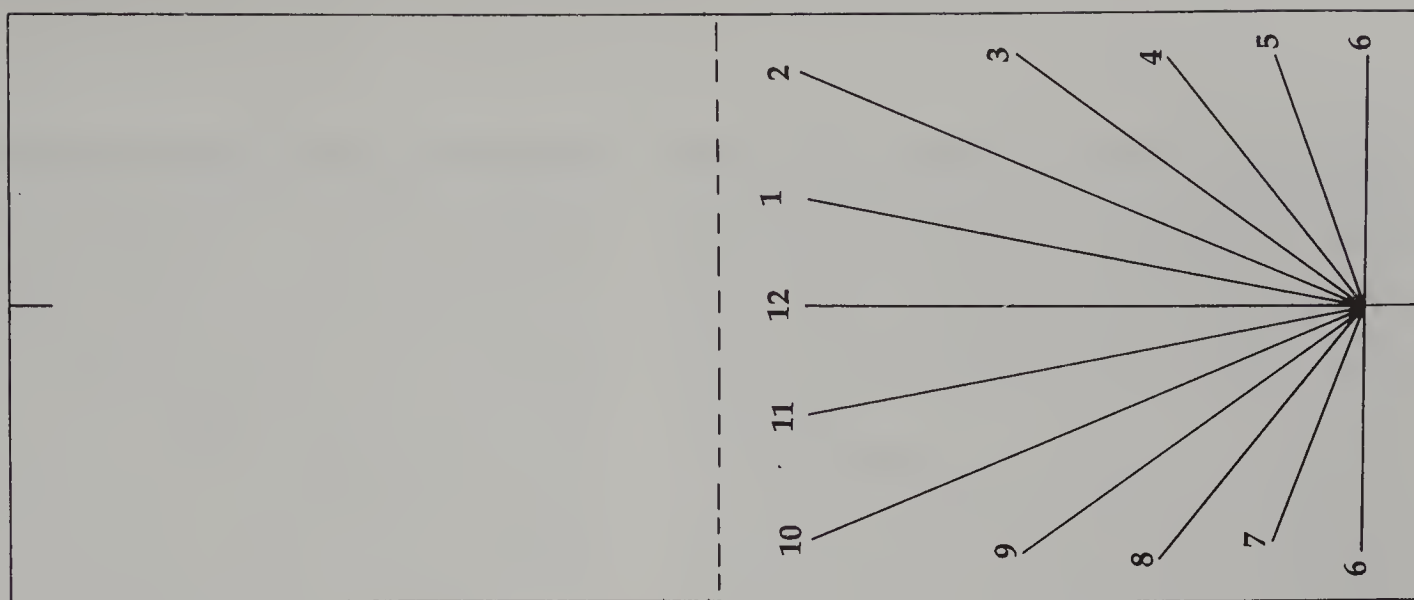
12) After 15 to 45 minutes, place your Sun Clock back in the spot you marked and turn it until the shadow of the string reads the correct time. How much did you have to change its orientation? Is there anything special about the direction the string faces on the Sun Clock?

Many people think that the Sun Clock must be turned slightly to follow the motion of the sun, thus making the clock read correctly. But as you discovered, the Sun Clock reads properly when placed in the same orientation each time. Sometimes you can find a second location where the Sun Clock will read properly the first time you go out. But only one orientation will work both times you check the time.

As this is a simple sun clock (also called a sundial), there are certain times of year when the clock will be less accurate early and late in the day. More sophisticated sun clocks would be more accurate.

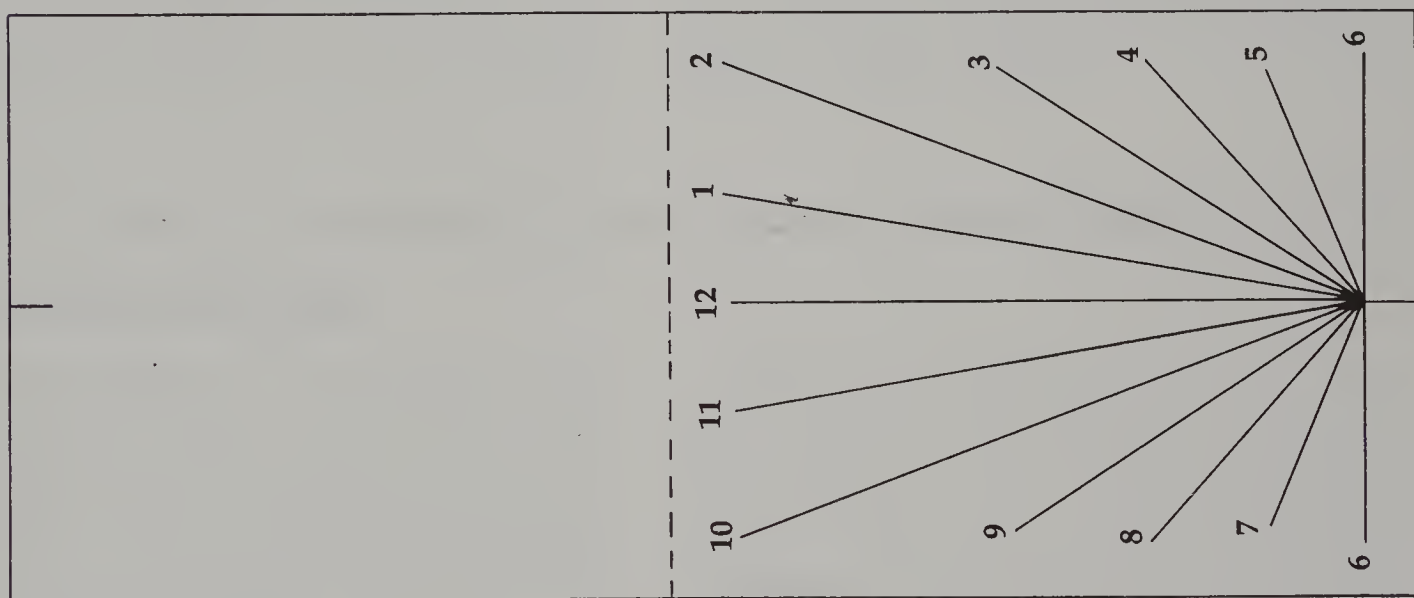
Now that you know how to orient your Sun Clock to have it read the correct time, you can use it to tell time. Just make sure you always orient the Sun Clock to the same direction before checking the string's shadow for the time.

CLOCK 3



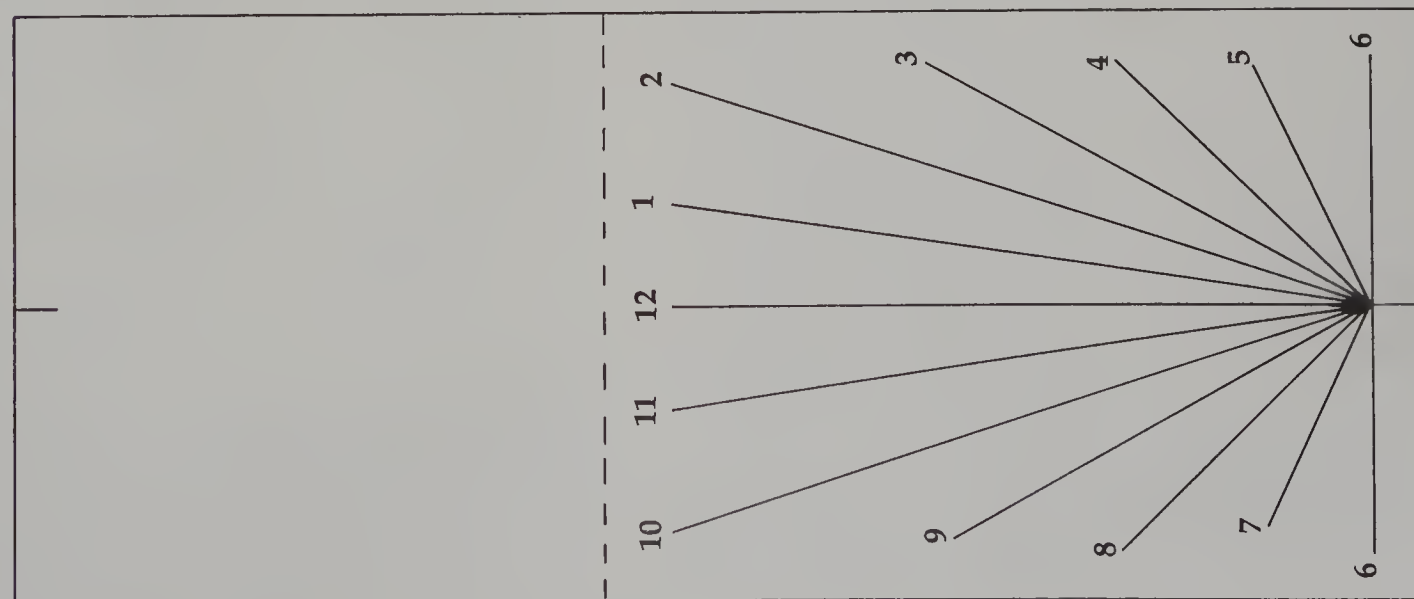
Clock 3: Use this Sun Clock if you live in: Washington, Oregon, Idaho, Montana, North Dakota, South Dakota, Northern Wyoming, Minnesota, Wisconsin, Michigan, Upper New York, Vermont, New Hampshire, Maine, Southern Canada

CLOCK 2



Clock 2: Use this Sun Clock if you live in: Northern California, Northern Nevada, Utah, Colorado, Southern Wyoming, Nebraska, Kansas, Iowa, Missouri, Illinois, Indiana, Ohio, Kentucky, Virginia, West Virginia, Maryland, Delaware, New Jersey, Pennsylvania, Lower New York, Massachusetts, Connecticut, Rhode Island

CLOCK 1



Clock 1: Use this Sun Clock if you live in: Southern California, Southern Nevada, Arizona, New Mexico, Oklahoma, Texas, Arkansas, Louisiana, Tennessee, Mississippi, Alabama, Georgia, Florida, North Carolina, South Carolina

You may have realized that the string is pointing from south to north. Astronomers define local noon in the Northern Hemisphere as the time when the sun is exactly in the south. Noon is also when the sun is at its highest point above the horizon. Since the 12 o'clock noon line is directly below the string, then the string must be oriented exactly on a north-south line to read properly at noon.

Sundials read local time, while your clock gives standard time or daylight saving time. The continental United States is divided into four time zones. Everyone agrees to say it is the same time every-

where in a time zone, even though the sun is not exactly in the same position. It is actually noon first at the eastern edge of the time zone and then noon about an hour later at the western edge of the time zone.

The boundaries of the time zones are not always straight in order to minimize communication problems between cities. In some cases the boundary is moved hundreds of miles east or west to keep an entire state in the same time zone. In other cases, the state is divided between two time zones because of geographic features such as a river.



Using a Sun Compass

If you know the correct direction to orient your Sun Clock, you can tell the time. If you know the time, you can also use the Sun Clock to tell directions. This activity lets you explore using your Sun Clock as a Sun Compass.

WHAT YOU NEED

- Pocket Sun Clock
- Watch
- Pencil or Chalk

WHAT TO DO

1) On a sunny day, go outside and find an open area with little shade. Mark where you are standing with the pencil or chalk.

2) Hold your Sun Clock level in your hand. Rotate it in your hand until it reads the correct time. Don't forget to subtract an hour from the time on your watch if it is daylight saving time. The Sun Clock is now facing to the south, with the string running in a north-south direction.

3) Use your Sun Clock to follow the instructions below:

- a) Take 5 steps north
- b) Take 5 steps east
- c) Take 5 steps north
- d) Take 10 steps west
- e) Take 5 steps south
- f) Take 10 steps east
- g) Take 5 steps south
- h) Take 5 steps west

4) If you successfully followed the directions, you should have ended at the spot where you started.

★★

Projecting an Image of the Sun

IMPORTANT:

DO NOT LOOK DIRECTLY AT THE SUN THROUGH BINOCULARS OR UNDER ANY OTHER CIRCUMSTANCE. PERMANENT EYE DAMAGE CAN OCCUR WITHOUT ANY FEELING OF PAIN.

This activity shows a safe method to examine sunspots on the sun's surface and to see how they change over just a few days.

WHAT YOU NEED

Binoculars

Tripod

Masking tape

Scissors

Piece of cardboard one foot square

White sheet of paper on a clipboard
or other hard surface

WHAT TO DO

1) Before you go outside, tape the lens cover to the opening of one side of the binoculars. If there is no lens cover, tape paper over the opening so no light can enter that side of the binoculars.

2) Extend the tripod to its full length and tape the binoculars securely to the tripod.

3) Cut a hole in the center of the cardboard the same size as the binocular

opening you did not tape closed. Slip the cardboard over the opening and tape it in place.

4) Go outside and point the binoculars roughly in the direction of the sun. REMEMBER, UNDER NO CONDITIONS LOOK DIRECTLY THROUGH THE BINOCULARS AT THE SUN. Loosen the control knobs on the tripod. Watch the ground behind the binoculars as you adjust the binoculars to point directly at the sun. A bright area of light will project on the ground when you have the binoculars pointed directly at the sun. It often takes some practice to get the binoculars aimed at the sun. One good indicator of how close you are to having the binoculars aligned is to watch the shadow of the binoculars on the ground. The shadow will be as small as possible when the binoculars are aimed at the sun.

5) Once you get the bright area of light on the ground, tighten the tripod control



knobs. Hold the piece of white paper about two feet behind the binoculars so that the area of light falls on the paper. The area of light is an image of the sun, but it may be out of focus. Adjust the focus knob on the binoculars until you get a sharp image of the sun on the paper. Sometimes you may see only part of the sun because the binoculars are not exactly aligned with the sun. If this occurs, carefully adjust the tripod so the full sun comes into view on the paper.

6) As you examine the image of the sun, you will notice that it is moving across the piece of paper. In a few minutes, the sun will go out of view completely, and you will need to adjust the tripod to bring the sun back into view. This occurs because the earth is rotating, causing the sun to appear to move across the sky throughout the day. You need to

regularly realign the binoculars to keep up with the sun's changing position in the sky.

7) Once you have the sun's image on the piece of paper, examine the entire solar surface carefully to see if you can find any dark spots. If you are not sure whether the spot is on the sun, in the binoculars, or on the paper, lightly tap the binoculars. If the spot moves with the sun's image, then it is a sunspot. Record on the piece of paper the total number of sunspots you see. If the sunspots are large, then make a drawing of them on the piece of paper for comparison on another day.

8) Repeat your observations daily, using a new piece of paper to record the number of spots and to compare the drawings of large sunspots.

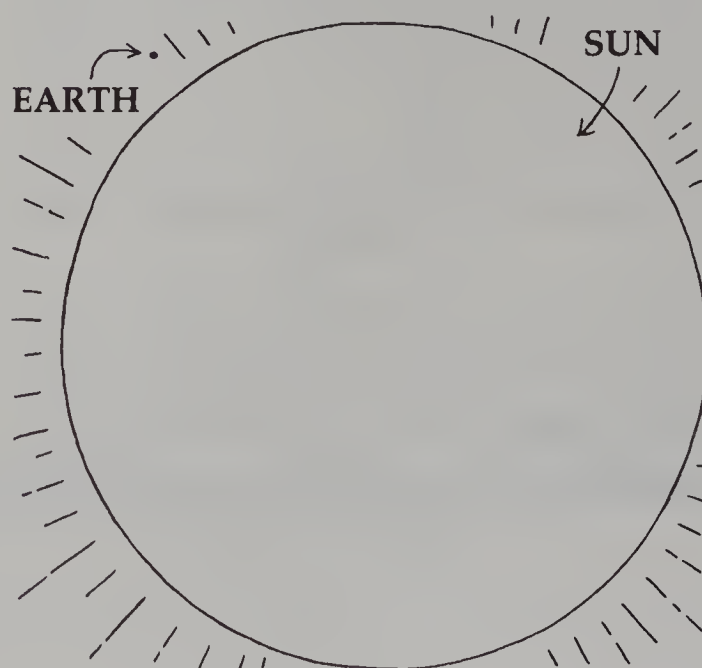
★★

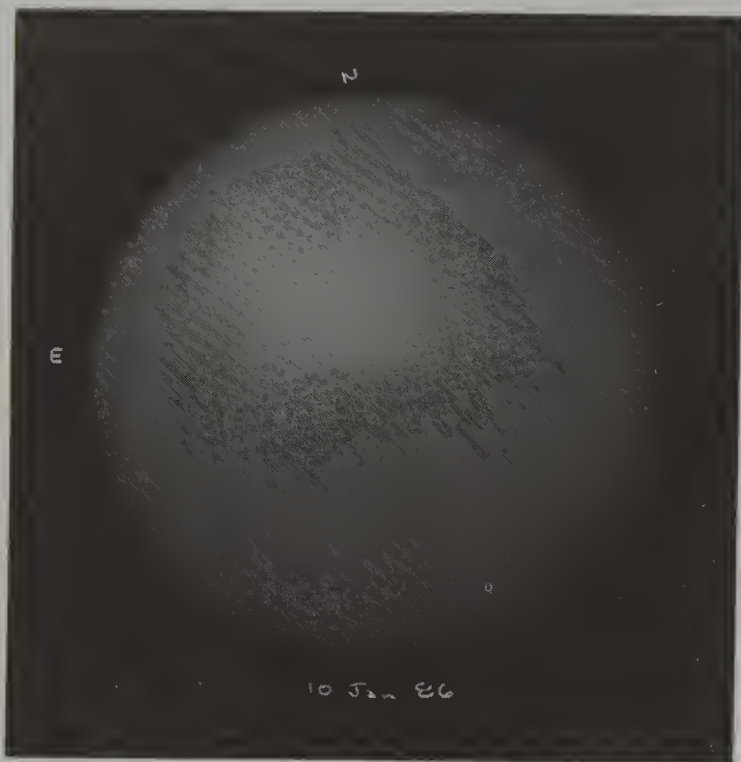
Sunspots and Solar Activity

Sunspots are the facial blemishes of the sun. These dark regions on the solar surface appear in generally predictable patterns and locations, growing larger over a few days to a few months and then fading away. Some sunspots are perfectly round, while others have very complex patterns. The larger spots all have dark regions embedded in a lighter surrounding area. Some spots seem to remain unchanged for days while others change shape and size dramatically in one day.

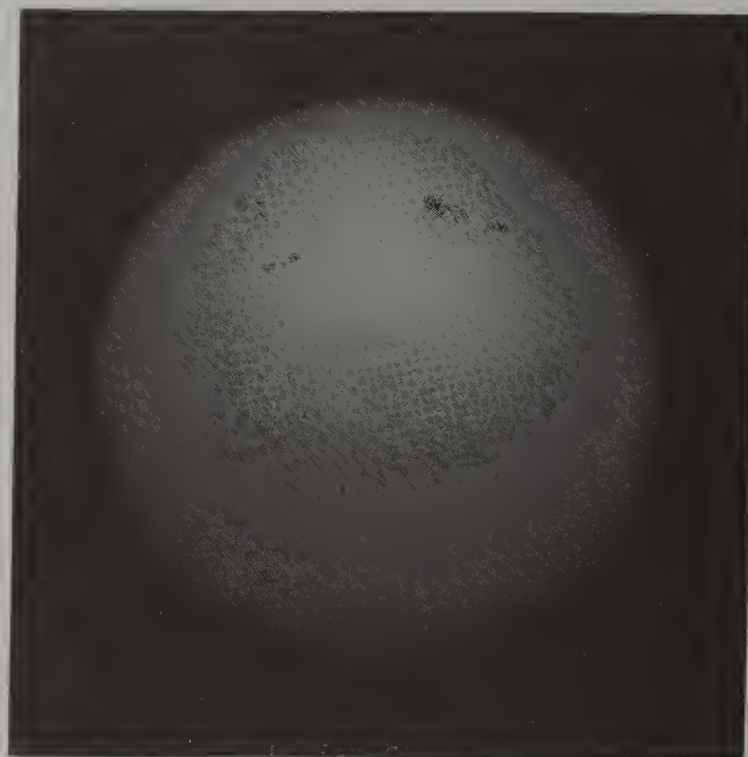
During certain years, such as 1986, the sun is almost free of these blemishes. But

Size of earth compared to sun.





Sun on January 10, 1986. Few sunspots visible.



Sun on February 12, 1989. Many sunspots visible.

five to six years later, the sun is covered with sunspots. In another five to six years, the sun is again blemish free. This eleven-year cycle between times of high sunspot activity has been documented for over 300 years.

Sunspots develop where high concentrations of magnetic field inhibit the flow of energy, producing cooler regions compared to the surrounding areas. These cool areas are still hot enough to melt lead (4,000 C/7,000 F), but as the cooler areas emit less light, they are darker than the hotter surroundings (6,000 C/11,000 F).

The diameter of the sun is 100 times that of the earth, so even though a sunspot appears small, it usually becomes

noticeable to the earthbound observer only when it is about the size of the earth.

During your observations of the sun, you may have noticed that the sunspots appeared to move across the surface of the sun. The sunspots themselves do not move significantly from where they erupt. The motion is due to the sun's rotation that carries them across the face of the sun. The surprising result from years of observation is that sunspot regions near the equator of the sun move faster than regions closer to the poles. A sunspot at the equator takes only 26 days to make a complete turn around the sun. At the poles—a far shorter distance around the sun—a sunspot takes 37 days.





Star Finding:



Making a Star Finder

A star map of the night sky helps you locate the different constellations (patterns) of stars in the same way that a road map helps you locate different cities on the earth. In this activity you construct a rotating Star Finder that shows you how to find the constellations visible in the night sky.

WHAT YOU NEED

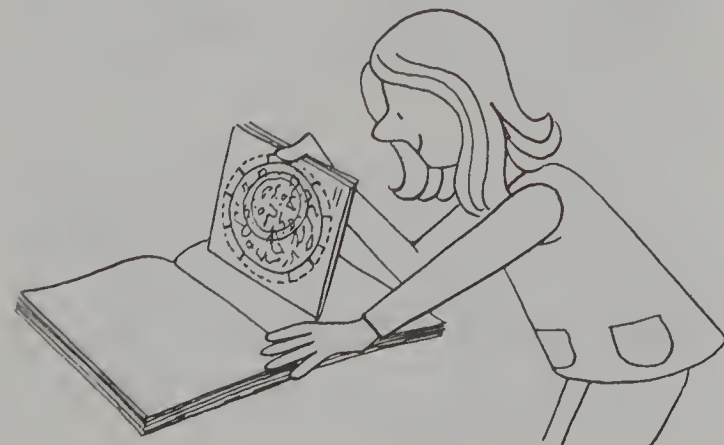
Star Finder pages from center of book

Scissors

Stapler

WHAT TO DO: CONSTRUCTING THE STAR FINDER

1) Carefully remove the centerfold pages from the book.



2) Cut out each page along the dotted lines as indicated.



3) Be sure the front and back of the Star Finder are exactly aligned.

4) Staple the front and back together, being sure the staples are placed as accurately as possible on the staple points.



5) Insert the first star wheel between the stapled pages so that the basic star field appears through the oval opening. Once the star wheel is completely inserted, test turning the star wheel to be sure it moves freely. Check to see that the black line under the dates on the star wheel approximately lines up with the edge of the star finder cover showing the time of day.



WHAT TO DO: USING THE STAR FINDER

1) Hold the Star Finder over your head so that the north on the Star Finder is facing north when you are outside. The stars showing in the oval opening are those that can be seen overhead at the time and date set on the Star Finder. The edge of the oval represents your horizon so that stars near the edge of the oval are low near the horizon in the sky. The center of the oval is the point directly overhead when you look up in the night sky. This point is called the zenith. Stars near the center of the oval will be high overhead when you are observing.

2) Before going outside to use the Star

Finder, practice using it inside. Assume you are going to observe at 9:00 p.m. on April 15. Set your Star Finder to show the correct star field by rotating the star wheel until April 15 on the star wheel is opposite 9:00 p.m. on the Star Finder cover. Remember to adjust for daylight saving time if necessary by subtracting one hour from your clock's time. Use the three-step process outlined below to practice finding Orion, one of the constellations easiest to see in the night sky.

- Determine what direction you will have to look by drawing an imaginary line from the center of the oval opening through Orion to the edge of the oval. Note this direction using the direction indicators shown around the oval's edge. You should find that Orion is just a little south of the west heading on the Star Finder.
- To determine how far from the horizon to the zenith you must look to see Orion, remember that the zenith is the point at the center of the oval and the point directly overhead when you go outside. You will see that Orion is about $\frac{3}{4}$ the distance from the center of the oval to the edge of the oval nearest Orion. When you go outside, you should therefore find Orion about $\frac{3}{4}$ of the distance from the zenith to the horizon.
- Finally, note the number of stars in the constellation and the pattern they make. The larger dots on the Star Finder represent the brighter stars in the sky. Orion has 7 stars, shaped roughly like an "H."

4) Follow the same three-step process to find the direction to look for Ursa Major (often called the Big Dipper), another constellation that is easy to find. You should find that Ursa Major is toward the east about $\frac{2}{3}$ the way from the horizon to the zenith, and has seven stars in the shape of a dipper.

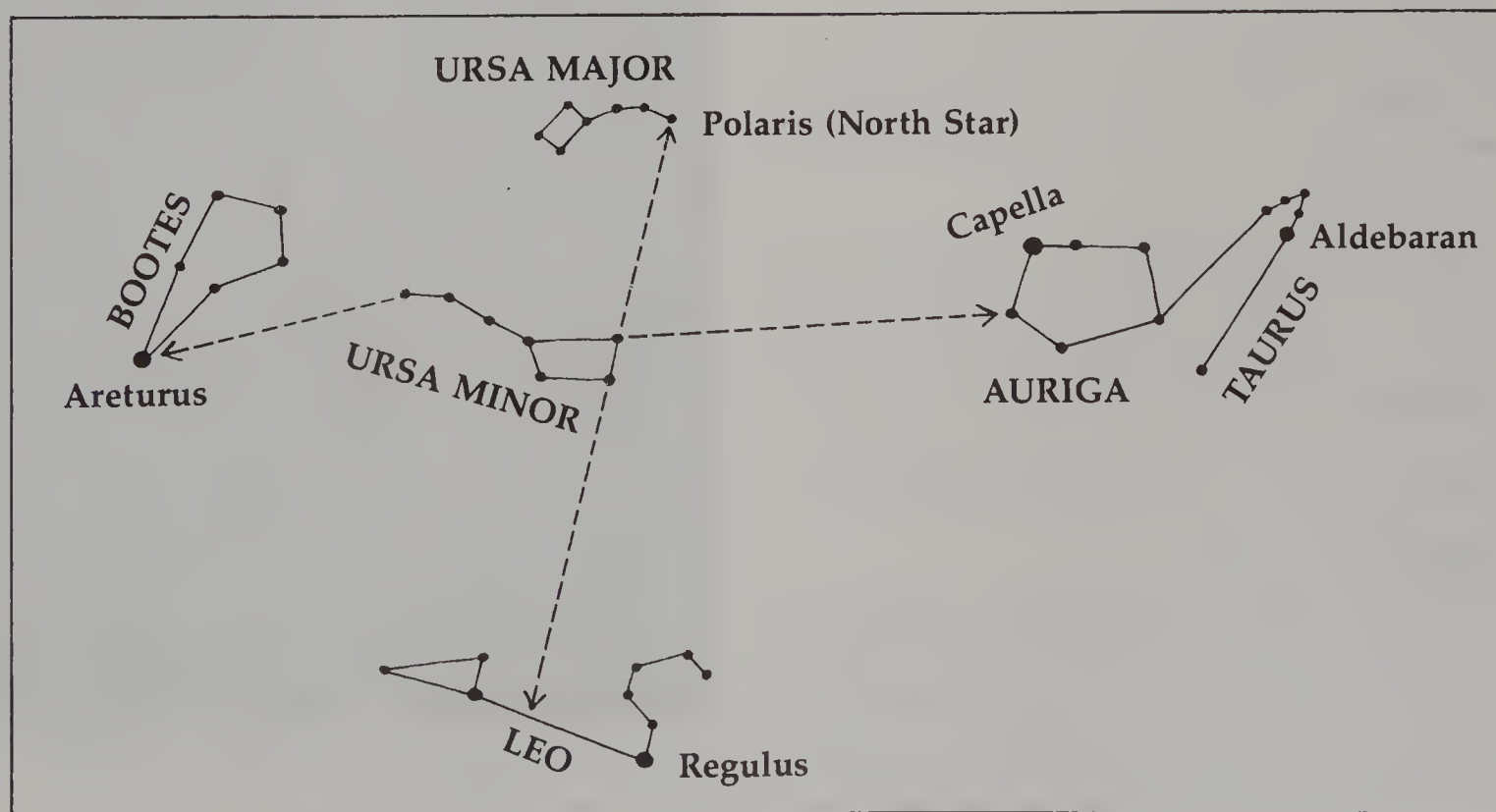
5) Now you are ready to go star finding in the night sky. It will be helpful if you have a small flashlight or penlight so you can read the Star Finder. If you have some red plastic, red construction paper, or a red balloon, cover the front of the flashlight with one of them. You will still be able to read your star chart by the red light, but the light will not reduce your ability to see faint stars the way white light does.

6) The basic star field on the second of the centerfold pages contains only the bright stars visible in the major constellations. These stars are the ones found

most easily, especially when viewing from a city where the many lights make it difficult to see faint stars. Once you are experienced at finding the bright stars on this side of the star wheel, you can flip the star wheel over and attempt to find the fainter stars and constellations. Some of these will not be visible until you observe from a location away from city lights.

Star Hopping from Constellation to Constellation

Once you become familiar with some of the brighter constellations, you can use these star fields to help find your way around the sky without referring to a star map. The star map on this page shows how to "star hop" between constellations using Ursa Major. Devise your own ways to use the stars in Orion to find other constellations.



★★

Using Binoculars to Find Faint Astronomical Objects

Now that you can find the constellations, they become markers for finding fainter astronomical objects that are usually visible only with the aid of binoculars or a telescope. The second star wheel shows you where some of these fainter objects can be found.

WHAT YOU NEED

Star Finder

Second Star Wheel on last of the centerfold pages

Binoculars

Flashlight (covered with red plastic if possible)

Clear sky

WHAT TO DO

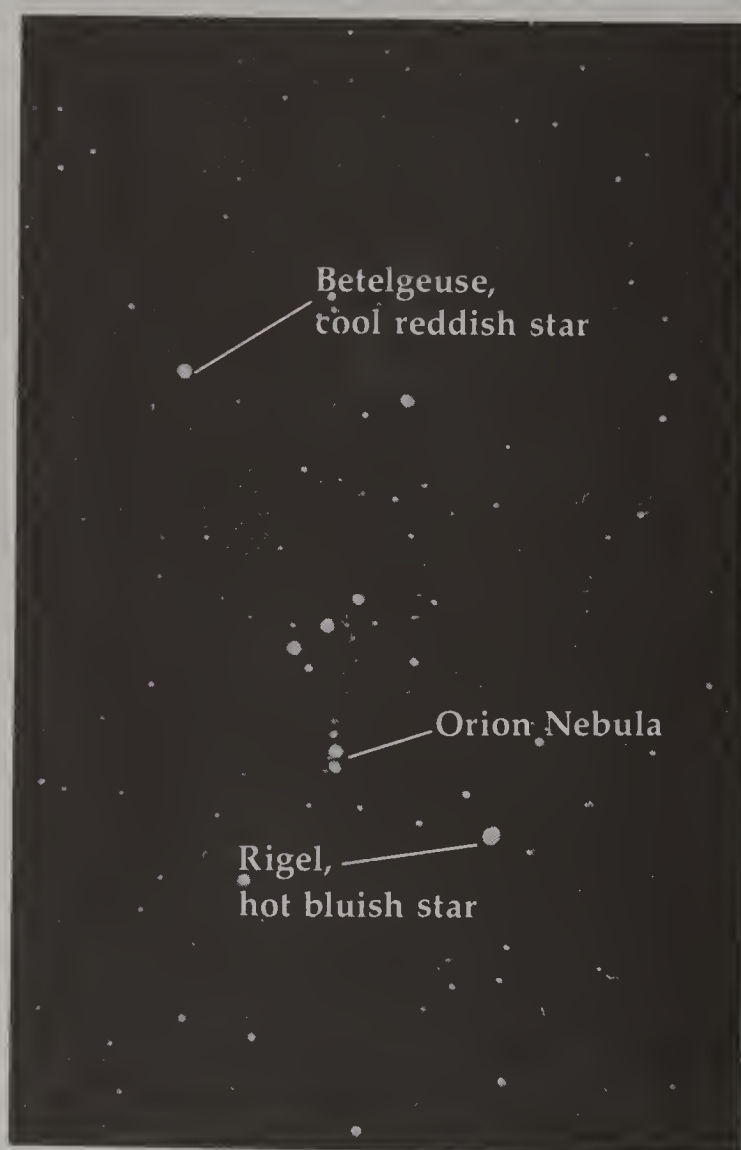
1) Cut out the second star wheel from the center of the book. Put it inside your Star Finder cover in place of the other star wheel.

2) Set the Star Finder for the time and date you wish to observe. Interesting objects to see through binoculars are identified by the circles on the map. The drawings on the back side of the star wheel show how the objects should look through binoculars.

3) For the greatest success in locating the fainter objects, you should observe from a place with a clear sky. You should also be as far from city lights as possible on a night when the moon is not too close

to being full. Before you try locating the faintest objects, be sure you have been in the dark for at least five minute. After this time your eyes become "dark-adapted" so you can see fainter objects. If possible, cover your flashlight with red plastic or paper so that your eyes will stay dark-adapted when you use the flashlight to read the Star Finder.

4) Be sure to dress warmly enough and then go out to enjoy locating examples of these different astronomical objects:



Objects that can be seen through binoculars in the constellation Orion.

Stars

Stars are large balls of gas. Their colors tell us how hot they are. Cool stars (2,000 C/3,600 F) are red, while very hot stars (50,000 C/90,000 F) are blue.

Double Stars

Some stars appear to be only one star until you look at them with binoculars. Then you discover they are two stars so close together that your eyes cannot separate them without the aid of the binoculars. A few of these stars actually revolve around each other. Most are extremely far apart, with one much closer to us than the other. They appear near each other because they are almost in a direct line from us.

Star Clusters

A group of stars will often form from the same large cloud of interstellar gas. They form clusters of stars that have dozens to hundreds of stars in open clusters, or hundreds of thousands of stars closely packed in a globular cluster.

Nebula

A large region of glowing dust and gas where new stars are forming into star clusters.

Galaxies

Billions of stars mixed with gas and dust. They are similar to but located far beyond the Milky Way galaxy in which our solar system is located.



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Creating a Constellation

★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★★

Many different cultures have associated mythological creatures and stories with different constellations of stars. This activity lets you create your own constellation figure and story for one constellation and then compare it to what other cultures see in the same star pattern.

WHAT YOU NEED

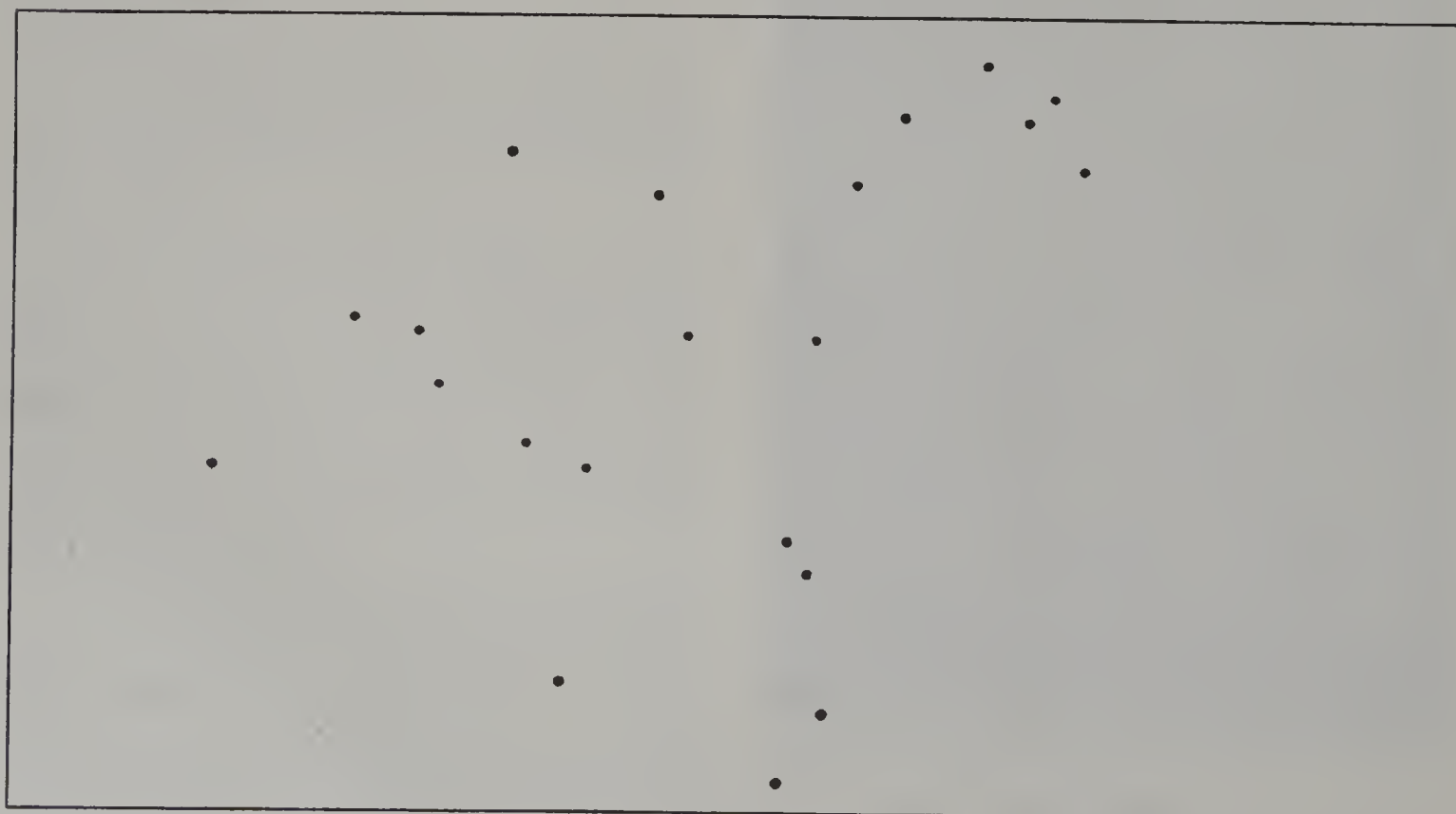
Star pattern on this page

Pencil, pen, colored pencils, or crayons

WHAT TO DO

1) Draw a mythological figure of your choice using some or all of the stars in the star pattern. These dots represent an actual pattern visible in the night sky. It includes a number of fainter stars in the constellation, so you may not recognize the constellation until you read the associated mythology.

2) After drawing your mythological figure, write a brief myth about the figure. Then read about what another culture saw in the star pattern.



This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There is no text or other markings on the paper.



Pacala the Peasant

A folktale in Romania depicts these stars as Pacala the Peasant. He lived during a time when heaven was much closer to the earth. People could communicate easily with God and even express their anger to him. One day a woman threw a dirty dress in God's face, telling him that he could wash it as she could not get it clean. The next day God moved heaven far above the earth.

People could not ask for God's advice anymore. Men didn't know when to plant their crops. Women did not know when the weather would be nice for hanging out the wash. Children could not ask for help with their studies.

Pacala, who owned a small farm in Romania, finally decided he just had to get God's advice. He realized it would be a long trip to heaven, so he decided to take his big wagon, with four oxen, as well as his small wagon, to hold supplies.

His wife helped him pack the wagons. He took a hatchet to cut wood for campfires, a lantern from his house for light, and the well from the front yard to be sure he had plenty of water. His wife gave him chickens and pigs to provide

food. As heaven was very far away, he realized that he would need his plow and some seed corn to plant along the way. He also loaded his sickle to harvest the corn.

The village priest brought the gold cross from the church so that Pacala could show he was a religious man.

Pacala was now ready to leave. But before he could go, the local dairyman came along with two pails of milk hanging from a wooden yoke across his shoulders. He wished to go along to discuss his problems with God. Then the village shepherd, with his two sheepdogs, asked to go along. Finally, Pacala's neighbor wanted to join them, thinking that Pacala would need a driver for the smaller wagon. Pacala gladly agreed, as he thought it would be nice to have company on such a long trip.

Finally the group set off on the long trip to heaven. Halfway up the steep, winding path they were stopped by the devil, who demanded to know where they were going. When Pacala and his companions would not respond, the devil grew angry and pulled an enormous dragon out of his bag. When this did not frighten Pacala and his friends, the devil pulled a hissing serpent from his bag. Pacala and his companions backed off slightly, but still did not respond to the devil's demand to know where they were going. The devil began gnashing his teeth, which made a horrible noise that people on earth thought was thunder.

The devil then produced a giant shaggy

bear, a wild horse, and an enormous scorpion to block the road to heaven. This made Pacala so mad that he tackled the devil, which started a wrestling match that still goes on today and produces the winds that moves the clouds and shakes the trees.

Pacala's friends joined in the battle. The shepherd's two dogs chased after the horse which fled across the sky. The shepherd drove the serpent away and the dairyman smashed the dragon's head with his wooden yoke. To this day the scorpion continues to reach out its claws, hoping to capture Pacala, but Pacala always stays just out of reach.

All the creatures in this story are visible in today's sky. During the summer, Pacala is in the middle of them all, almost directly overhead. The Big Dipper is part of the shaggy bear, and the many stars making up the dragon wind around the area of the North Star. The cross from the church is nearby as the Northern Cross, also known as Cygnus. The chickens are eating in a small cluster called the Pleiades. The scorpion is far to the south as the constellation Scorpius, and the serpent makes a long, winding line of stars just below Pacala. If you observe far from city lights, where the sky is dark and when the moon is not out, you can see the road Pacala followed. The dairyman's milk spilled and covered the path, which we call the Milky Way.

Although the Romanians saw Pacala in this star pattern, the ancient Greeks saw the great hero, Hercules.





Hunting Planets



The word *planet* comes from the Greek word for “wanderer” because the planets slowly change their location among the constellations. Although they cannot be placed on the star maps in a permanent position, there is a narrow band of constellations where they are always found. This activity tells you what to look for when trying to observe the planets.

WHAT YOU NEED

Star Finder (with full star field facing up)

Pencil that can write on the star field

Observing hints from this page

WHAT TO DO

1) Set the Star Finder for the time and date you wish to observe. The stars located between the two large circles are called the zodiac constellations. The planets visible with the unaided eye (Mercury, Venus, Mars, Jupiter, and Saturn) are always located within this band of constellations.

2) Go outside and try the different strategies listed below to help you determine which points of lights might be planets.

Look for stars that are average to very bright points of light that do not fit into the star patterns on your map. Mark these on your star map with a pencil. Go back out during the next few weeks to see if the points of light change their positions compared to the nearby stars. Stars will not change their position, while Mercury, Venus, and Mars will move significantly. Jupiter and Saturn will show only a slight movement that may be difficult to detect. Neptune, Uranus, and Pluto are not visible without the aid of binoculars or telescope.

Look to see how much the light from your chosen objects flickers compared to nearby stars. Stars tend to twinkle more than the planets, although it is often difficult to detect a difference, especially when the objects are near the horizon where the earth’s atmosphere makes every object twinkle more.

Because Mercury and Venus orbit the sun between the earth and the sun these planets are usually exceptionally bright and located near the rising or setting sun. Mercury is so close to the direction of the sun that it is usually not visible unless you have an extremely clear horizon in the direction of the rising or setting sun.

Look at the objects through binoculars

or telescope to see if they have any of these traits:

Mercury

Yellowish in color and brighter than any star, but not as bright as Venus or Jupiter.

Venus

Brighter than any star or other planet. Usually seen with a crescent or gibbous phase because its orbit around the sun is inside the earth's orbit. Yellowish-white in color because it is completely covered with clouds.

Mars

Appears slightly orangish in color. Usually faint, but at times of closest approach to the earth can be as bright as Jupiter. Easily confused with some of the reddish stars in the zodiac constellations. No distinguishing surface features are visible.

Jupiter

Yellowish-white in color and brighter than any star. Viewed through binoculars, as many as four moons are visible as faint points of light along an almost straight line running through the planet. Observe how quickly the moons move by observing the planet for a number of nights. Many telescopes will faintly show the bands of different colored clouds that cover the planet.

Saturn

Yellowish in color and slightly fainter than the brightest stars. The planet's rings are visible through most telescopes, but not usually through binoculars.

Look on the monthly planet maps provided by one of the many organizations producing regular sky information. *Odyssey*, *Astronomy*, and *Sky and Telescope* are some of the best-known magazines, and are in many libraries. Your local planetarium may also provide this information. Compare the locations they supply with the positions you found.





Observing Meteors



Small chunks of rock from space, usually no bigger than a grain of sand, regularly enter the earth's atmosphere. We see a brief streak of light as the movement of the rock heats up the air, making the air glow. Many people call these streaks of light shooting stars, but they are really meteors. This activity helps you identify the best time and the most comfortable way to observe these occurrences.

WHAT YOU NEED

Meteor Observing Log

Pencil

Flashlight (covered with red material if possible)

Blanket for laying on the ground, or a comfortable lawn chair

WHAT TO DO

1) Decide when and where to go observing so you have the greatest chance of seeing meteors. A few important points to remember are:

On most moonless nights away from city lights, you can see 7 to 14 meteors per hour. During certain times of the year, the earth passes through an area of space where there is a higher con-

centration of rocky material, producing a meteor shower. The meteors do not come down like rain, but a careful observer can see 30 to 60 meteors per hour under good conditions. Although you can try to observe meteors any night, you will find the chart with your Meteor Observing Log helpful in identifying the best days to observe a meteor shower.

Meteors occur all over the sky, so you will want to observe away from trees and buildings that block your view.

Meteors are usually faint, so it is best to observe away from city lights and when the moon is not up. Remember that you will not see the fainter meteors until after your eyes have adapted to the dark for at least five minutes.

Observe after midnight. You are then on the front of the earth as it travels through space, so more rocky material falls into the atmosphere. You can visualize this if you think of your finger as the earth. Run your finger across a dusty table, pretending the dust is rocky debris in space. The front of your finger as you move it forward will collect the most dust—just like the

earth when it captures rocky debris in space.

2) Go outside on the chosen date and time. Make yourself comfortable with your head back so that you can look at as much of the sky as possible at one time. You can never predict where you will see the next meteor, so binoculars will not be helpful because they let you see only a small part of the sky.

3) Use your Meteor Observing Log to keep track of the number of meteors you see in each 15-minute interval.

4) Try some of the following experiments when observing a meteor shower:

Count the number of meteors you see when observing several hours before midnight compared to observing the same number of hours after midnight on the same night.

Determine how quickly meteor activity builds by observing at the

same time of night for the same number of days before and after the date of peak meteor activity.

Save your log and repeat the observations of the same meteor shower a year later.

IMPORTANT METEOR SHOWERS

<i>Date</i>	<i>Shower Name</i>	<i>Approximate Number of Meteors Observed Per Hour</i>
January 4	Quadrantids	40
April 22	Lyrids	15
May 5	Eta Aquarids	20
July 29	Delta Aquarius	20
August 12	Perseids	50
October 21	Orionids	25
November 2	Taurids	15
November 18	Leonids	15
December 14	Geminids	50
December 22	Ursids	15

METEOR OBSERVING LOG

<i>Time (at 15-minute intervals)</i>	<i>Number of Meteors</i>	<i>Comments</i>
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____



More Information About Astronomy

If you would like to read more about astronomy, your local library may have some of the resources listed below. If not, look under "Astronomy" in the catalog. Try to find the most current references, as our understanding of astronomy changes quickly.

Books

Exploring the Night Sky with Binoculars by Patrick Moore, published by Cambridge University Press in 1986. Clear instructions on how to use binoculars to see many celestial objects.

The Star Book by Robert Burnham, published by Astromedia and Cambridge University Press in 1983. Excellent star maps for locating objects in the night sky.

Exploring the Planets, an Activity Book by Robert Cichowski and Dennis Schatz, published in 1991 by Pacific Science Center, 200 Second Ave. No., Seattle, WA 98109.

Astronomy Projects for Young Scientists by N. Apfel, published by Arco in 1984. Good, simple astronomy activities for readers 12 and older.

Voyage Through the Universe published by Time-Life Books 1988-90. Beautifully produced astronomy series for readers 12 and older.

Asimov's Library of the Universe by Isaac Asimov, published by Garth Stevens in 1988-90. Nicely produced astronomy series for readers ages 9 to 12.

Exploring the Night Sky by Terence Dickinson, published by Camden House in 1987. Well illustrated and readable description of objects in the universe. Includes basic maps for stargazing.

Our Universe by Roy Gallant, published by National Geographic in 1986. A beautiful overview of the main topics in astronomy.

The NOVA Space Explorer's Guide by Richard Maurer, published by Clarkson N. Potter in 1985. Excellent overview of many astronomy topics.

Astronomy Today by Dinah Moche, published by

Random House in 1985. Regularly updated overview of many astronomy topics.

The Grand Tour by Ron Miller and William Hartmann, published by Workman in 1981. A guide to the solar system, illustrated with photographs and paintings.

Eclipse by Bryan Brewer, Published by Earth View in 1991. A thorough overview of when, how, and why we have eclipses.

101 Questions and Answers About the Universe by Roy Gallant, published by Macmillan in 1984. Short but useful answers to many basic questions in astronomy.

Magazines

Odyssey, a colorful astronomy magazine for youngsters from Kalmbach Publishing, 1027 N. 7th St., Milwaukee, WI 53233.

Astronomy, a colorful magazine for more advanced readers than *Odyssey*, is also published by Kalmbach Publishing.

Other Important Resources

The Astronomical Society of the Pacific has many excellent resources, including:

"Selecting Your First Telescope," complete information on what you need to know to buy a telescope.

"Astronomy on Computers," description of 89 programs for use on the most popular types of computers.

"Tapes of the Night Sky," two audio cassettes and star maps to familiarize the listener with the stars and constellations of each season.

Write the Astronomical Society of the Pacific at 390 Ashton Ave., San Francisco, CA 94112 for a full catalog of resources.

"Sky Challenger," a set of star wheels and activities for exploring the constellations, is available from the Lawrence Hall of Science, University of California, Berkeley, CA 94720.

"Sky Calendar," a monthly calendar of what to see in the night sky, is available from Abrams Planetarium, Michigan State University, East Lansing, MI 48824.

★ \$6.95 U.S./\$9.95 CAN ★

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